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SELF-CONFIDENCE AND METACOGNITIVE PROCESSES

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Abstract. This paper examines the status of Self-confidence trait. Two studies strongly suggest that Self-confidence is a component of metacognition. In the first study, participants (N=132) were administered measures of Self-concept, a newly devised Memory and Reasoning Competence Inventory (MARCI), and a Verbal Reasoning Test (VRT). The results indicate a significant relationship between confidence ratings on the VRT and the Reasoning component of MARCI. The second study (N=296) employed an extensive battery of cognitive tests and several metacognitive measures. Results indicate the presence of robust Self-confidence and Metacognitive Awareness factors, and a significant correlation between them. Self-confidence taps not only processes linked to performance on items that have correct answers, but also beliefs about events that may never occur.
Key words: Confidence ratings, Metacognition, Self-confidence, Metacognitive Self-monitoring.

This paper examines the relationship between Self-confidence measured during performance on typical cognitive tests and several conceptually related constructs. These latter constructs include problem-solving strategies, broad self-concepts, metacognitive awareness, and beliefs about occurrences of some future events. The aim is to further our understanding of Self-confidence and establish its status within the taxonomy of cognitive/metacognitive processes.

The Self-confidence Factor

Our procedure for the assessment of Self-confidence is integrated within the typical test-taking activity. Immediately after responding to an item in a test, participants are asked to give a rating indicating how confident they are that the chosen answer is correct. Confidence is usually expressed in terms of percentages. The confidence ratings for all attempted test items are averaged to give an overall confidence score.

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There is a considerable amount of empirical evidence showing individual differences in confidence ratings. The correlations between accuracy and confidence scores from the *same* test are usually significant and tend to average between .40 and .50. Nevertheless, numerous studies suggest that correlations between confidence ratings from *different* cognitive tests are high enough to define a broader and more general Self-confidence factor that is separate (yet related) to the factors that underlie intelligence (Kleitman & Stankov, 2001; Nietfeld & Schraw, 2002; Pallier *et al.*, 2002; Schraw *et al.*, 1995; Schraw & Nietfeld, 1998; Stankov, 1998, 1999, 2000; Stankov & Crawford, 1996, 1997). That is, people who are more confident on one cognitive task, relative to other people, tend to be more confident across other tasks as well. Statistical evidence supportive of the Self-confidence factor is consistent with the evidence that is used to argue that ability and personality factors are psychological traits.

We shall use the term Self-confidence (Confidence) to denote a psychometric factor based on confidence judgments from several cognitive tests. Confidence judgments meet the following two conditions: (1) They are systematic and reliable; (2) They have meaningful overlap with cognitive abilities – i.e., higher accuracy is linked to a higher confidence level (see Harvey, 1997; Keren, 1991; Stankov, 1999). At present, there is considerable information about its relationship with cognitive abilities (Stankov, 1998; Stankov & Crawford, 1996, 1997; Stanovich, 1999) and personality (Pallier *et al*., 2002). These studies show that Self-confidence is not strongly related to ability and personality constructs (see Stankov, 1999, for a review). However, the evidence for a meaningful relationship between Self-confidence and some other conceptually related constructs is relatively scarce.

The relationship between Self-confidence and hitherto unexplored constructs

In this paper we explore the relationship between Self-confidence and several constructs that have not been related to it in the past. These include test-taking strategies elicited by a newly constructed Verbal Reasoning Test (VRT) and two broad classes of self-concepts: (a) Memory and reasoning (see the rationale and description of MARCI test below); and (b) Five self-concepts (Self-Worth, Scholastic Competence, Intellectual Ability, Athletic, and Job Competence) that were studied by Neemann & Harter (1986). VRT and MARCI are employed in both Studies reported in this paper and, being new, are described below.

In Study 2, we shall examine the relationship between Self-confidence and processes tapped by a well-known questionnaire measure of metacognition – Metacognitive Awareness Inventory (MAI, see Schraw and Dennison, 1994). In Study 2 we also extend the measurement of Self-confidence beyond the typical test-taking situation and ask participants to state their level of confidence in the likelihood that some future events will happen. These events may or may not take place. If Self-confidence in such events happens to be related to Self-confidence in the accuracy of the just-provided answer to a test item, there is yet another reason to assume that Self-confidence trait is indeed a trait on the borderline between personality and abilities as argued by Stankov (1999).

Self-confidence and cognitive strategies in test-taking

In a series of studies Allwood and Montgomery (1984, 1987) provided an insight into the link between Self-confidence and the cognitive processes involved in test-taking (see also Tversky & Fox, 1995; Tversky & Kahneman, 1986, 1987, 1990; Tversky *et al*., 1992; Tversky & Koehler, 1994). These authors claimed that four types strategies are involved in the response retrieval processes during work on cognitive tasks. These are: "Immediate Recognition" (the answer stood out at once or suddenly as the correct one); "Inference" (the answer seemed probable due to other things that I thought of); "Intuition" (the answer felt probable, but I didn't have any other support for it), and "Guessing" (neither of the alternatives seemed appreciably more probable than the other). Allwood and Montgomery (1984, 1987) showed that immediate recognition was associated with a higher proportion of correct responses than with the other identified strategies. Confidence ratings were highest for the "Immediate Recognition" (i.e., memory) strategy, followed by "Inference" (i.e., reasoning), "Intuition" and "Guessing" strategies respectively. The studies to be reported in this paper were inspired in part by these findings since it is reasonable to assume that the strategies which an individual may utilize, and beliefs about ones competence to utilize them during test-taking, are related to Self-confidence. To examine this proposition two new instruments were developed and used in the present studies.

The Verbal Reasoning Test (VRT). The items employed in the Verbal Reasoning Test were designed specifically to elicit the four response selection strategies described by Allwood and Montgomery (1984, 1987). Table 1 provides examples and further explanation. To elicit the "immediate recognition" strategy General Knowledge questions were included. These items covered content areas such as geography, history and lexical knowledge. Questions

were also designed to elicit the "guessing" response strategy. These items were taken from a number of Encyclopedias. The topics covered entailed a very specialized knowledge of biology, statistics, history and psychology. The third category of questions was constructed to elicit reasoning ("inference") responses. The subject matter of the questions did not contain any information or knowledge content that would be easily accessible from memory. However, hints were built within both the question and the alternatives provided so that participants could "reason" in order to find a correct response to the question. There were a number of items that were intended to generate the "intuition" response strategy. These questions were similar to those of the "reasoning" type but without easily recognizable hints.

Table 1: Examples of Items Designed to Elicit "Recognition", "Inference", "Intuitive" and "Guessing"

An example of "answer recognition" items (knowing answer)
Which of the following words means the same thing as 'facilitate'? 1. Strip; 2. Turn; 3. Help; 4. Bewilder; 5. Intend. (Ans.: 3)
An example of "inference" items (reasoning answer)
A term 'dyschronaxis' is used to denote*: 1. A superior ability to judge tactile stimulus; 2. An impaired ability to maintain a course of action and/or line of thought; 3. An enhanced sense of smell; 4. An impaired ability to judge what time it is; 5. An impaired ability to walk. (Ans.: 4)
An example of "intuitive" items
Which of the following mythological characters belongs to Aboriginal culture?** 1. Imana; 2. Kojiki; 3. Koopoo; 4. Danavas; 5. Hymir. (Ans.: 3)
An example of "guessing" items
What do "morayeels", "aulopus purpurissatus" and "alabes dorsalis" have in common? 1. They all belong to the osteichthyes class; 2. They all come from the family clupeidae; 3. They all come from the family gobiesocidae; 4. They all belong to the asteroidea class; 5. They all come from the ascididae family. (Ans.: 1)

* To get the correct answer to the "reasoning" questions, participants had to try to generate the hypothesis about the meaning of a key word in a question stem. In the example above, even though the word "dyschronaxis" would be unfamiliar to the vast majority of people, it is possible to infer the correct meaning of this word by employing "lexical" reasoning – to partition the word into two parts – "dys" – meaning impairment and "chronaxis"- meaning time. Hence, the correct answer is (4), An impaired ability to judge what time it is.

** Although very few participants were expected to have extensive knowledge of Aboriginal culture, it was considered that articulation of the word (Aboriginal names in Australia are characterized by a specific articulation—Woolloomooloo, Yarrawarra) might predispose selection of the correct alternative.

Memory and Reasoning Competence Inventory (MARCI). This instrument was designed to capture declarative aspects of metacognition – awareness of oneself as a cognizer and learner. The development of this instrument is grounded in the construct of Self-concept – a generic term that refers to subjective perceptions of one's own relative strengths and weaknesses in relation to some general or specific activities. Stankov and Crawford (1997) argued that some well-established areas of academic Self-concepts might be related to Self-confidence. These authors suggested that scales for the assessment of Mathematics and Verbal facets of academic Self-concept, such as those used in the Self-Description Questionnaire-II (SDQ) (Marsh, 1990), would be particularly relevant when comparing cognitive test performance. However, Stankov and Crawford (1997) found only limited support for the hypothesized relationship. Thus, English Self-concept was found to share a low (.22) correlation with Confidence rating measures on a Vocabulary test and Mathematic Self-concept had a similar low correlation with confidence ratings based on the Raven's Progressive Matrices (RPM) Test. Nietfeld and Schraw (2002) reported stronger relationships between a Mathematic Self-efficacy Questionnaire and confidence judgments assigned to RPM and a Probability Test (r's ranged between .31 to .44, $p<.05$).

However, a closer examination of the empirical evidence for the constructs of Self-confidence, Self-concept and Self-efficacy suggests a major distinction between these in terms of broadness. Self-concept and Self-efficacy tend to be domain specific, that is, limited to a particular domain such as Verbal, Maths, and Physical. It is therefore possible that participants viewed their performance on cognitive tasks such as Raven's Progressive Matrices or Vocabulary tests as being totally unrelated to their performance on Maths and English subjects. This, in turn, could have resulted in the low correlation between confidence ratings on RPM and measures of Mathematics or English Self-concept in Stankov/Crawford studies.

Our assumption in this paper is that measures of Self-concept which focus on activities relevant to test-taking behaviour (i.e., memory and reasoning), should be related to confidence scores that can be obtained from tests tapping these cognitive abilities. Thus, if people rely on different response selection strategies to solve cognitive tasks (Allwood & Montgomery, 1984, 1987), then their perception of themselves in relation to the relevant cognitive processes should be linked to metacognitive Self-confidence. That is, if 'immediate recall' and 'inference' are strategies used to answer questions on a test, then self-beliefs in the competency of one's own *memory* and *reasoning*

abilities can aid our understanding of the level of confidence that we hold in our answers.

To investigate this proposition, MARCI was designed according to the model of Self-concept outlined by Marsh and colleagues (Marsh, 1986; Marsh, Byrne & Shavelson, 1992; Marsh & Shavelson, 1985). Self-concepts are formed through experience with, and interpretations of, one's environment. They are especially influenced by the evaluations of significant others, reinforcements, and attributions for one's behaviours. MARCI incorporates the Internal/External (I/E) Frame of Reference Model proposed by Marsh (1986, Marsh *et al*., 1992). The I/E model suggests that English (verbal) and Mathematics Self-concepts are distinct because they are formed in relation to both external and internal comparisons. According to the external comparisons principle, a person compares his/her ability in math and reading with the perceived ability of other students in these areas. According to the internal comparisons principle, a person also compares self-perceived ability in math with his/her self-perceived ability in English. The items that comprise the *Memory and Reasoning Competence Inventory* (MARCI) reinforced the External ("I can remember more material than the average person") and Internal ("Compared to my other cognitive abilities [e.g., attention, reasoning], my memory is good") comparisons. It was expected that beliefs in memory and reasoning competence would be associated with the overall level of Self-confidence assessed with cognitive tests which call upon these types of cognitive processes.

Aims

The main aim of the two studies presented in this paper is to further our understanding of Self-confidence and its status within the taxonomy of cognitive/metacognitive processes. These latter processes include test-taking strategies and broad self-concepts assessed with MARCI. In Study 1, they also include measures of broad self-concepts identified by Neemann & Harter (1986). In Study 2 we employ questionnaire measures of metacognitive processing developed by Schraw and Dennison (1994) and measures of beliefs in the likelihood of occurrence of some future events. The studies were also designed to establish whether constructs that are not expected to relate to Self-confidence show low correlation with it. In Study 1, these include measures of personality traits. In Study 2, they are measures of mental speed.

Study 1

This study has two main objectives. The first is to confirm the link between confidence judgments and response selection strategies–cognitive processes

that have been identified as important for test-taking behaviour (Allwood & Montgomery, 1984, 1987). The second aim is to investigate the relationship between confidence ratings and the Memory and Reasoning Competency Inventory (MARCI). In addition, the study examines the relationship between Self-confidence, MARCI, and measures of personality and broad Self-concepts that are not captured by MARCI. In our previous work, apart from a low correlation with Openness (see Pallier *et al.*, 2002), Self-confidence showed low correlation with the Fig Five personality factors. It is expected that this finding will be replicated. The relationship between Self-confidence and broader Self-concepts (e.g., Self-Worth, Scholastic Competence, Intellectual Ability, Athletic, and Job Competence) that are assessed with instruments developed by Neemann & Harter (1986) have not been studied previously. It is expected that broad Self-concepts of Scholastic Competence and Intellectual Ability will be related to Self-confidence assessed during test-taking.

Method

Participants

Participants in this study were 132 First and Third Year Psychology students (40 males) from the University of Sydney. Mean age was 20.65 (SD=2.95). They were tested in groups of twenty.

Test and Questionnaires

- *The Verbal Reasoning Test (VRT)*, consisting of 24 (multiple choice, five-alternatives) items described earlier in Table 1. Participants were required to answer a question, state their level of confidence, and indicate which response selection strategy they used. Four options for the response selection strategies (i.e., "knew the answer", "reasoned", "guessed" and "if other, please specify") were provided next to the question. Participants were required to select one of these options.
- The *Memory and Reasoning Competency Inventory* (MARCI) consists of 18 items (nine items for each component), generated on the basis of the Internal/External frame of references Marsh (1986). Items were intermixed. The respondents used a 5-point Likert type scale ranging from "Strongly Disagree" to "Strongly Agree" to indicate the strength of their beliefs.
- Five aspects of a *Broader Self-concept* (or profiles) scale (Neemann & Harter, 1986). These were: Global Self-Worth profile (measures one's general feeling about the self: liking the kind of person one is); Scholastic Competence profile (indexes whether the person feels competent to master coursework); Intellectual Ability profile (measures general intellectual competence, whether one feels as smart or smarter than other students), Athletic

profile (assesses whether one feels competent at physical activities and sports); and Job Competence profile (assesses whether one feels proud of the work one does, and feels confident one can do a new job).

- *Big Five personality questionnaire* (NEO-FFI; Costa & McCrae, 1985): Openness (O), Conscientiousness (C), Extraversion (E), Agreeableness (A), and Neuroticism (N).

Procedure

Participants were asked to complete the questionnaires, followed by the Verbal Reasoning Test (VRT). For each question in the VRT, participants were asked to select the answer, rate their confidence level and indicate the selection strategy they employed to answer the question. All measures were given in a pencil-and-paper format.

Results

Table 2 summarizes the descriptive statistics for the variables used in this study. The percentage of correctly answered questions for the overall Verbal Reasoning Test is only 54%. However, considering the nature of the test (only 30% of the items were typical General Knowledge questions, with another 30% being the "inference" type, and 40% of the questions being more of the "guessing" nature), this outcome was expected. The overall confidence (the average of confidence ratings on all items in the test) is slightly lower than accuracy (49.22%).

The percentage of correct answers and confidence level for each reported response selection strategy is also presented in Table 2. Participants' confidence and accuracy are highest for the items with "knowing" response selection strategy (90.16% and 94.79% respectively), and lowest for the items with "guessing" response selection strategy (24.83% and 31.65% respectively). Items with the "reasoning" strategy fell in the middle of the range (52.70% and 57.77% respectively). The differences between the three strategies are significant at $p<.01$ level for both confidence and accuracy measures.

Confidence judgments assigned to different categories are interesting in their own right, as they reflect the different levels of uncertainty which people hold in their answers. It is apparent that participants do *not* assign more homogeneous ratings (i.e., the standard deviation is rather high) to the items that they "knew" the answer for (M=90.16, SD=11.49) than they did to the most other categories. This suggests that individual differences at the "knew"

category are considerable. On the other hand, confidence scores for the "guessed" questions tend to be more homogeneous (M=24.83, SD=5.41) and more accurate. That is, it approximated a chance level to answer a multiple-choice, five-alternatives question correctly by guessing (i.e., 20%). "Guessing" (41.3%) and "reasoning" (36.2%) are the most common response selection strategies reported by the participants (see Table 2).

Table 2: Descriptive Statistics for all Variables Used in Study 1

Variables	N	Mean	Std. Deviation	Alpha
VRT Accuracy	132	54.02	9.95	.49
VRT Confidence	132	49.22	10.19	.86
Accuracy by strategies				
Knowing answer	128	94.79**	10.11	
Reasoning answer	129	57.77**	19.30	
Guessing answer	117	31.65**	13.67	
Confidence by strategies				
Knowing answer	129	90.16**	11.49	
Reasoning answer	130	52.70**	12.18	
Guessing answer	131	24.83**	5.41	
MARCI				
Memory Inventory	128	3.43	.84	
Reasoning Inventory	128	3.54	.88	
General Self-concept				
Global Self-Worth	126	17.84	.85	
Scholastic Competence	129	10.87	.71	
Intellectual ability	124	11.80	.83	
Athletic Competence	129	10.50	.80	
Job Competence	125	11.79	.68	
NEO-FFI				
Openness	130	31.39	.65	
Conscientiousness	130	33.83	.76	
Extraversion	130	35.75	.80	
Agreeableness	130	29.16	.66	
Neuroticism	130	27.83	.78	

Note. **p<.01

Overall, the construction of the VRT was successful in eliciting the response selection strategies identified by Allwood and Montgomery (1984, 1987): there was 92% agreement between the strategy presumed to be elicited by an

item, and the dominant strategy that people employed to answer the questions. Furthermore, these strategies generate confidence ratings that are in agreement with expectations. Descriptive statistics presented in Table 2 also indicate that people hold similar levels of belief in the competency of their memory and reasoning abilities as assessed by MARCI (overall means are 3.43 and 3.54 respectively).

Table 2 also shows the reliabilities of the measures used in the study. Reliabilities (Cronbach's alpha) for the majority of measures are within an acceptable range (Anastasi & Urbina, 1997). The reliabilities of the confidence scores, and MARCI are reasonable (.86, .84 and .88 respectively), indicating that people were stable across different confidence estimates, and in their beliefs in memory and reasoning competence.

Table 3: Pearson Product Moment Correlations between Variables Employed in Study 1

	ACC	CON	MEM	REA	GLO	SCH	INT	ATH	JOB	OPE	CON	EXT	AGR	NEU
Verbal Reasoning														
Accuracy		38	15	15	04	40	25	-14	16	04	18	-09	-15	-11
Confidence			18	38	14	41	38	-06	34	26	12	00	-12	-10
MARC Inventory														
Memory				14	15	27	27	07	14	11	27	22	10	-10
Reasoning					09	38	42	14	33	30	15	14	-04	-10
Self-concept Profiles														
Global						36	32	11	40	03	14	33	17	-61
Scholastic							74	-03	50	08	13	05	04	-27
Intellectual								11	44	22	11	13	01	-26
Athletic									12	-10	-04	14	-05	-08
Job										15	19	20	18	-24
Personality														
Openness											28	26	15	15
Conscientiousness												31	32	-11
Extraversion													38	03
Agreeableness														-04
Neuroticism														

Note. (1) All correlations higher than .16 are significant on α=.05 level, (2) all correlations higher than .23 are significant on α=.01 level, and (3) all correlations are given without decimal points.

Correlations are presented in Table 3. From the pattern of correlations, it is apparent that Openness is the only personality factor that has a significant, though weak, correlation (.26) with the level of confidence on the Verbal

Reasoning Test. Interestingly, however, Openness shares no significant correlation with the accuracy of the Verbal Reasoning Test. This may be due to the nature of the VRT (i.e., the presence of highly unfamiliar items). Intellectual and Scholastic profiles correlate with both confidence and accuracy, while the Job profile correlates with confidence only. Confidence shares a medium (r=.38) correlation with accuracy.

The Reasoning Competence score from the MARCI has a medium positive (r=.38, p<.01) correlation with confidence, and low (r=.15, p=.06), correlation with accuracy on the Verbal Reasoning Test. The low correlation with the accuracy of performance on this test was expected considering the nature of the test (i.e., the presence of non-homogeneous and highly unfamiliar items, including items of the guessing nature). The Memory Competence score mimics this pattern, but its correlation with confidence is lower (r=.18, p<.05), yet significant. Overall, the Reasoning Competency facet of the MARCI shows a promising pattern of correlations with other measures. It has medium correlations with the Scholastic, Intellectual Ability and Job Competency profiles (r's=.38, .42 and .33 respectively, p<.01), and the Openness (or "Intellect") personality dimension (.30, p<.01), while its correlations with Memory and Athletic profiles are very low and non-significant (both r's=.14, p>.05), indicating good convergent and discriminant validity. The Memory Competence facet of the MARCI has a somewhat similar pattern of correlations to the Reasoning Competency facet, however, with a lower range of correlation coefficients. Interestingly, it has significant correlations not with Openness but with the dimensions of Extraversion and Conscientiousness.

Table 4: Model Summary of the Hierarchical Multiple Regression Analysis with Confidence Scores as a Criterion

Model	Model Predictors	R	R^2	R^2 Change	Std. Beta
1	Accuracy	.38	.14	.14**	.38**
2	Accuracy	.50	.25	.11**	.32**
	Memory Inventory				.09
	Reasoning Inventory				.32**

Note. The results are provided only for blocks of variables that were significant predictors of confidence estimates; **p<.01

Table 4 summarizes the results of a four-block hierarchical multiple regression with confidence as a dependent variable, and accuracy, memory and reasoning competence, self-competence, and personality variables as relevant blocks. As can be seen in Table 4, accuracy and MARCI scores contribute

significantly to the overall confidence level (i.e., change in R^2 is significant at the .05 level). Neither self-competence profiles nor personality variables contribute significantly after accuracy and MARCI scores are controlled for (i.e., the change in R^2 after adding personality variables was 4%, while the R^2 of self-competence profiles added 5%, $p>.05$ for both blocks of variables). Accuracy scores explain 14% of variance in the general confidence level and MARCI adds a further 11%, accounting together for 25% of the variance. The results presented in Table 4 also show that accuracy and Reasoning scores are the only significant predictors of the general level of confidence people assigned to the items of the Verbal Reasoning Test.

Discussion

In line with expectations, and previous findings in the literature (Allwood, Granhag & Johansson, 2000; Allwood & Montgomery, 1984, 1987), there is consistency between confidence ratings and the cognitive response strategies which people employ to reduce uncertainty in test-taking situations. That is, confidence for the "knowing" strategy was the highest, followed by confidence for the "reasoning" strategy, with "guessing" displaying the lowest level of confidence in performance accuracy. These findings are not surprising given the level of subjective uncertainty associated with each response strategy. That is, immediate answer recognition is associated with the smallest degree of uncertainty and the highest number of correctly answered items. Not remembering the answer but being able to infer it from the context is associated with partial uncertainty and reasonable accuracy of performance. At the same time, guessing is associated with absolute uncertainty and with a chance level of performance. This suggests that individuals' subjective perception of uncertainty during test taking is major determinant of the level of confidence.

In addition to strategy manipulations, we also administered a newly developed Memory and Reasoning Competence Inventory (MARCI), personality questionnaire, and measures of broad self-concepts. Clearly, MARCI scores have high reliability, and good discriminant and convergent validity. The results of regression analysis also indicate that, indeed, Reasoning scale from MARCI has incremental predictive validity over VRT accuracy.

With the exception of Openness to Experience, personality dimensions are not related to the general level of confidence. Also, some established Self-concept constructs and their associated measures such as Academic Self-concepts (Marsh, 1990) (i.e., Math and Verbal Scales), and Intelligence, Scholastic and Job Competence profiles (Neemann & Harter, 1986) might be important for the general level of Confidence. However, they lose their predic-

tive power after controlling for the accuracy of performance and assessment of the competence of one's own memory/reasoning abilities. Overall, the results of this study support the hypothesis that self-beliefs about basic cognitive processes employed during test-taking are related to the levels of Self-confidence.

Study 2

Study 2 extends the findings of Study 1 in three ways. First, it examines the relationship between MARCI and the *general* Self-confidence factor defined by confidence ratings from seven cognitive tests. The selection of cognitive tests for Study 2 was consistent with the fluid and crystallized (Gf/Gc) theory of intelligence (Horn & Noll, 1994). Second, although Study 1 provided hints that MARCI taps into metacognitive processes, further validation is needed. The Metacognitive Awareness Inventory (MAI) is a 52-item questionnaire specifically designed to assess awareness of metacognitive processes. This questionnaire is based on the assumption that there are two major components of metacognition, namely, Knowledge about Cognition and Regulation of Cognition (Schraw & Dennison, 1994; Schraw, 1998). Schraw and colleagues have shown that Knowledge of Cognition refers to what students know about themselves as learners, awareness of one's strong and weak points, strategies, and the conditions under which strategies are most effective. Regulation of Cognition, on the other hand, corresponds to knowledge about the ways people plan and implement strategies, monitor and correct comprehension errors, and evaluate their efforts. In previous studies, these two domains of metacognition were strongly interrelated, indicating that knowledge and regulation work together to assist in self-regulation (Schraw, 1998; Schraw & Dennison, 1994). Furthermore, MAI has significant, albeit low correlation, with measures of confidence ratings on a reading comprehension test (Schraw & Dennison, 1994).

The Memory and Reasoning Competency Inventory (MARCI) is likely to tap Knowledge about Cognition. Moshman (1994) proposed a similar construct that he labeled as the constructive metareasoning component of metacogntion – "a type of metareasoning that involves the operation of cognition on one's own reasoning" (p. 141), a sort of "reasoning about reasoning" (p. 141), and, accordingly, reasoning about memory. By establishing that scores on MARCI and MAI questionnaires show significant correlation, we can validate the claim that the MARCI taps aspects of the self-reported metacognitive processes.

Third, although it has been reliably demonstrated that there are individual differences in confidence judgments on diverse cognitive tests, it is unclear whether the general level of confidence extends outside the scope of *typical* cognitive tests. In real life, people are often asked to state their opinions about some personal or world event. These opinions may not necessarily have *immediate*, or even future, correct and incorrect answers. Nevertheless, people often indicate how sure they feel about their views. Study 2 investigates whether the confidence which people have in their cognitive performance generalizes to judgments beyond those based on immediate performance. For this purpose we designed 23 opinion statements.* In each statement, participants had to estimate the likelihood (from 0% to 100%) of occurrence of a particular event. The events ranged from those pertinent to Australia (i.e., becoming a republic), to the World in general (i.e., virtual reality becoming the main entertainment in the future), and to themselves (i.e., succeeding in a chosen university course). After stating their beliefs, participants were asked to indicate how *sure* they were of their opinions on a scale from 1 (Not sure at all) to 5 (Very sure). The mean of these judgments indexed the level of assurance that participants hold in their opinions. For brevity, we shall refer to it as "Sureness" score. For data analyses purposes in this paper, no use of the probabilities assigned to potential events was made.

Method

Participants

The study is based on 296 First Year Psychology students (85 males).* Mean age was 19 (SD=3.15). Participants were tested in groups of twenty. All participated in the experiment as part of their course requirements.

Tests

A battery of cognitive tests based on the Gf/Gc theory of intelligence was assembled for this study. The Horn-Cattell theory is a hierarchical model that defines intelligence in terms of independent broad abilities (Carroll, 1993). According to the model, fluid intelligence (Gf) reflects basic abilities in reasoning, while crystallized intelligence (Gc) reflects the extent to which the individual has been able to learn and use her/his culture through education

* The opinions were similar to the Probability and Certainty Test (see Brim, 1955). That scale was originally designed to assess attitude content – intensity (direction and the strength of convictions) and probability expectations. In addition to assigning probability statements, participants had to indicate their certainty level using 5-point scale (Very sure to Not sure at all).

* The original sample included 311 students. Fifteen participants were excluded on the basis of their limited language skills.

and experience. The model regards Gf and Gc as second-order factors (Horn & Noll, 1994).

Tests descriptions

● *Quantitative Switching task (QST)* (attention switching measure). Participants were given sixty number strings. For odd items they had to search the string and report the largest even digit. For even items they had to report the smallest odd digit. The test had a 2-minute time limit. Examples: 1). 3 5 6 4 5 2 3 7 (6); 2). 8 7 9 6 5 8 2 2 (5).

● *Verbal Reasoning Task (VRT)*. The test consisted of 30 items as described in Table 1 (5 new reasoning items and a practice item were added to the version of this test employed in Study 1).

● *Nonsense Syllogisms (Syllogisms)* Test from the Kit of Reference Tests for Cognitive Factors (French, Ekstrom & Price, 1963). The test consists of sixteen two-choice items, that ask the participant to evaluate quality of the reasoning with a nonsense content (i.e., All trees are fish. All fish are horses. Therefore all trees are horses [Ans. Valid reasoning]).

● *Esoteric Analogies Test* (Stankov, 1997). The test contained 20 items: Example: CHICK is to HEN as CALF is to: BULL, COW, COAT, ELEPHANT (COW).

● The 10-item *General Knowledge (GK)* Test employed taken from the "Gf/Gc Quickie Test Battery" (Stankov, 1997). Example: Leucocytes are: (1) Small bones in our hands; (2) Small blood cells; (3) Small hair cells in our ears; (4) A form of bacteria; (5) Male hormones.

● *Probabilistic Reasoning Test.* This test was adapted from a High School Mathematics textbook. It included 14 standard probability reasoning tasks, measuring participants' ability to estimate sample space, and a range of probabilities of within this space (Marlin & Nilsson, 1999). Example: In two child families, what is the probability of there being 2 sons? 2/4; 1/4**;** 5/6; 3/5; 2/5 (Ans.:1/4).

● *Conditional Reasoning Test*. The test consisted of 12 conditional reasoning (i.e., If p then q) items. The typical aim of conditional reasoning tasks is to see whether people can make inferences associated with four conditional rules – Modus Ponens (MP), Denial of Antecedent (DA), Affirmation of the Consequent (AC) and Modus Tollens (MT). For an extensive review of conditional reasoning tasks see Manktelow (1999). Participants were asked to evaluate quality (truth or falseness) of the items. The questions' context was trivial: If the class is on, there is no noise. There is noise, thus, there is no class (Answer: True, i.e., MT rule).

Tests 2-5 contained confidence judgments. Tests 2-4 were computerized and they included measures of reaction time (RT) for each item. Cognitive

tests 1, 6, 7 and all questionnaires (measures 8-10 below) were given in a pencil-and-paper format. Tests 1, 3, 6 and 7 are markers of Gf, while tests 4 and 5 are markers of Gc. The place of the Verbal Reasoning test within Gf/Gc taxonomy is unclear at this stage. The nature of this test, however, suggests that similarly to the Esoteric Analogies Test, the VRT might be a factorially complex measure, loading on both Gf and Gc factors. In addition to the cognitive tests, the following three instruments were employed:

- *Metacognitive Awareness Inventory (MAI)* is a 52-item questionnaire (Schraw & Dennison, 1994). Example: I ask myself periodically if I'm meeting my goals.
- "*Sureness*". Participants were given 23 opinion statements in which they had to estimate the likelihood (from 0% to 100%) of the occurrence for a variety of events. After providing the estimate, participants were asked to indicate how sure they were about their opinions on a scale from 1 (Not sure at all) to 5 (Very sure). For example: "The probability that a cure for AIDs will be eventually found is about – in 100". How sure you are of your opinion?
- *Memory and Reasoning Competence Inventory (MARCI)*. The test consisted of 16 items, 8 items for each component. The original questionnaire employed in Study 1 was shortened, some items were replaced, and existing items were improved (i.e., stems were shortened, wording made more clear, etc.). The items' response categories were changed to be the same as the ones in the Self Descriptive Questionnaire II (SDQII, Marsh, 1990). The respondents had to evaluate the extent to which each statement described themselves using a 6-point Likert scale ranging from False to True. As in Study 1, the items were intermixed.

Procedure

Participants were asked to provide biographical details (e.g., gender, age, first language, years in Australia [if overseas-born]). A timed test – Quantitative Switching – was administered first. It was followed by the MARC Inventory. The remainder of the tests were intermixed and presented in a random manner.

Results

Descriptive statistics and reliabilities. Table 5 summarize the descriptive statistics and reliabilities for the variables used in Study 2. The mean accuracy scores and reliability estimates presented in Table 5 are generally consistent with previous findings with similar cognitive tests (Kleitman & Stankov, 2001; Pallier, Roberts & Stankov, 2000; Pallier *et al*., 2002; Stankov, 2000). The reliabilities (Cronbach's alphas) for the majority of accuracy measures used in this study are somewhat low, yet within acceptable levels for research

purposes (Anastasi & Urbina, 1997). In accordance with the results of our previous studies (Kleitman & Stankov, 2001; Pallier *et al*., 2002; Schraw *et al*., 1995; Stankov, 1998; Stankov & Crawford, 1996, 1997) and Study 1, the reliabilities of confidence judgments for all tests are consistently high (.82 to .95, mean of all alpha coefficients=.89), and they are overall higher than reliabilities of both accuracy (mean of all alpha coefficients=.57) and reaction time (mean all alpha coefficients=.84) measures.

Table 5: Descriptive Statistics & Reliability Coefficients (Cronbach's alpha) for the Variables in Study 2

	Mean	SD	Alpha
Accuracy			
Quantitative Switching	33.43	12.87	N/A
Verbal Reasoning	46.08	9.96	.59
Syllogisms	58.28	15.43	.53
Esoteric Analogies	63.53	16.01	.66
General Knowledge	59.00	15.68	.51
Probability Reasoning	83.99	14.04	.67
Conditional Reasoning	63.15	16.93	.47
Confidence			
Verbal Reasoning	42.16	11.02	.91
Syllogisms	75.88	11.96	.95
Esoteric Analogies	64.89	12.04	.87
General Knowledge	60.18	15.48	.82
Reaction/Overall Time			
Verbal Reasoning	45.87	1.38	N/A
Syllogisms	14.95	50.65	.82
Esoteric Analogies	11.18	30.61	.86
Metacognitive Measures			
MAI	3.98	0.51	.93
"Sureness"	3.52	0.52	.89
MARCI: Memory Inventory	3.87	0.97	.88
MARCI: Reasoning Inventory	4.16	0.83	.88

Note. Reliability coefficients for accuracy, confidence and bias scores of the Verbal Reasoning Test were calculated without 'guessing' items. Hence, all three alpha coefficients are based on 16 items. The reliability coefficient for the Quantitative Switching task cannot be computed, as it is a speeded test.

The MARCI has high internal consistency (alphas=.89 for both memory and reasoning components). This replicates the findings from Study 1 and implies that people hold stable beliefs in their memory and reasoning competence. The overall Metacognitive Awareness Inventory (MAI) also had a high reliability estimate of alpha=.93. Internal consistency was also high for the "Sureness" measure (alpha=.89), indicating consistency in the level of 'sureness' that people give to their opinions about potential happenings.

Confirmatory factor analysis: Evidence for broad confidence and metacognitive awareness factors. To investigate the structure of cognitive and metacognitive measures, a confirmatory factor analysis (CFA) was carried out using the Maximum Likelihood (ML) method from the AMOS program (Arbuckle & Wothke, 1999). The model tested was based on findings from previous studies in our laboratory utilizing similar batteries of tests (Stankov, 2000). This research suggests that the present study ought to yield either 4 or 5 factors: (1) Fluid intelligence and (2) Crystallized intelligence – two factors corresponding to ability measures based on accuracy scores; (3) a separate Speed factor (with loadings from all timed scores); (4) a Self-confidence factor (with loadings from all Confidence ratings scores) and, perhaps (5) a Metacognitive Awareness factor with loadings from Metacognitive Awareness, Memory and Reasoning inventories.

The four-factor model with collapsed Factors 4 and 5 from the above list was fitted first. The model, however, had a relatively poor fit: χ^2_{122}=300.87, χ^2/df=2.5, the Root Mean Square Error of Approximation (RMSEA)=.07, and Goodness-of-Fit Index is (GFI)=.89. A five-factor model was fitted next, with the Metacognitive Awareness, Memory and Reasoning Inventories defining the fifth – Metacognitive Awareness – factor. Several modifications to this initial model were carried out. A five-factor model with 5 covariances set to zero, produced the most acceptable measures of fit: χ^2_{121}=206.97; χ^2/df=1.71; the RMSEA=.05 (its 90% Confidence interval was .04; .06), and GFI=.93. All the abovementioned indices are within levels that indicate a reasonably good model fit (Byrne, 2001). The results of this CFA are presented in Table 6 and interpretation of this model follows.

Factor 1: Fluid Intelligence (Gf). This factor is defined by the accuracy scores from Conditional Reasoning, Quantitative Switching, Syllogisms, Esoteric Analogies and Probabilistic Reasoning tests. Notably, it also has loadings from the Verbal Reasoning Test and Reasoning and Memory Competence Inventory. This is also a rather broad factor in terms of the cognitive processes captured (including a verbal component) its reasoning, and therefore Gf nature, is rather pronounced. The factor captures such cognitive processes as attention switching, inductive, deductive and numerical

reasoning. The fact that Reasoning Competency score of the MARCI also load on Factor 1 validates the authenticity of this measure. It is worth noting that the "Sureness" measure has a significant *negative* loading on this factor. This suggests that high Gf scores imply a lack of readiness to express confidence in predictions of events that may or may not happen.

Table 6: Confirmatory Factor Analysis from Study 2.

Factors	Gf	Gc	Confi-dence	Test-taking Speed	Meta-cognitive Awareness	h^2
Accuracy						
Quantitative Switching	0.50					0.25
Verbal Reasoning	0.34	0.42				0.39
Syllogisms	0.54					0.30
Esoteric Analogies	0.53	0.21		0.26		0.47
General Knowledge		0.82				0.67
Probability Reasoning	0.48					0.23
Conditional Reasoning	0.64					0.42
Confidence						
Verbal Reasoning		0.22	0.57			0.42
Syllogisms			0.64			0.40
Esoteric Analogies			0.90			0.81
General Knowledge		0.57	0.40			0.58
Test-taking Speed						
Verbal Reasoning				0.46		0.29
Syllogisms				0.69		0.48
Esoteric Analogies				0.93		0.86
Metacognitive measures						
Metacognitive Awareness					0.69	0.47
Sureness	-0.31		0.39		0.22	0.28
MARCI: Memory Inventory	0.19				0.37	0.17
MARCI: Reasoning Inventory	0.38				0.54	0.44
Factor Inter-correlations:						
Gf	1	0.34	0.34	0	0	
Gc		1	0.20	0	0	
Confidence			1	0	0.41	
Speed				1	0.30	
Metacognitive Awareness					1	

Note: Gf=Fluid Intelligence; Gc=Crystallized Intelligence.

Factor 2: Crystallized Intelligence/Verbal Reasoning (Gc). Salient loadings on this factor are from the accuracy score of the Verbal Reasoning Test and both accuracy and confidence scores of the General Knowledge Test. Esoteric Analogies accuracy and Verbal Reasoning confidence also have significant but small loadings on this factor. This is also a rather broad factor, with dominant verbal and learned components.

Factor 3: Self-confidence. This factor was exclusively defined by high and salient loadings of the confidence scores. Clearly, this is a broad Self-confidence factor. Notably, the 'Sureness' in one's opinion measure also has a loading on this factor.

Factor 4: Speed. This factor is predominately defined by high loadings from the measures of time on the Syllogisms, Esoteric Analogies and Verbal Reasoning tests. Esoteric Analogies accuracy also has a small loading on this factor. This factor reflects Speed of Test-taking (Robert & Stankov, 1999).

Factor 5: Metacognitive Awareness. This factor has salient loadings from the two MARCI facets, MAI, and 'Sureness' measures. This factor clearly taps broad metacognitive processes.

The bottom part of Table 6 displays correlations between factors. Those correlations that were not significant at the .01 level were fixed to equal zero. Not surprisingly, two ability factors (Gf and Gc) share a positive correlation (r=.34). The Self-confidence factor has substantial (and the *highest*) correlation with the Metacognitive Awareness factor (r=.41) and notable correlations with the Gc and Gf factors (r=.20 and r=.34 respectively). In contrast to the Self-confidence factor, the Metacognitive Awareness factor does not correlate with the two ability factors. The Speed factor was orthogonal to all but the Metacognitive Awareness factor (r=.30).*

Discussion

The main aim of this study was to further our understanding of the Self-confidence factor, by establishing its relationship to metacognitive processes. The

* Also, two three-block hierarchical multiple regressions with abilities (Gf & Gc), Speed and Metacognitive composites as the relevant blocks; and the Self-confidence composite (comprised of a sum of four confidence scores; Model A) and the "Sureness" measure (Model B) as the dependent variables. As much of the outcomes can be anticipated from the results of factor analysis, we only summarize these results here. In *Model A*, only ability factors (both with positive betas) and the Metacognitive Awareness factor (predominately, Reasoning component of the MARCI and Sureness measure, all with positive betas) contribute significantly to Self-confidence (each block explaining 16% and 17% of the variance of this factor). In *Model B*, however, only Gf ability factor contributes significantly and with a *negative* beta, to the "Sureness" level (explaining 3% of variance). In addition, the Metacognitive Awareness factor (predominately, the MAI) contributes significantly to the overall level of "Sureness", explaining a further 12% of the variance.

MARCI was developed to reflect people's beliefs about competency in their cognitive abilities (memory and reasoning) captured by typical tests of intelligence. The fact that the inventory has notable associations (loaded together) with performance on the cognitive tests which predominantly use relevant cognitive abilities (memory and reasoning) indicates the veracity of this measure. Also, the inventory loaded together with the Metacognitive Awareness Inventory (Schraw & Dennison, 1994) and the "Sureness" measure, providing clear evidence that performance on the MARCI belongs to the metacognitive domain and defines a Metacognitive Awareness factor. In terms of theories of metacognition, the inventory reflects metacognitive knowledge about one's own skills and abilities (Knowledge about Cognition, Schraw, 1998), the type of knowledge that Moshman (1994) also classified as constructive metareasoning. Importantly, the Metacognitive Awareness factor is correlated with the Self-confidence factor. That is in agreement with the findings of Study 1.

Another aim of this study was to investigate the broadness of the Self-confidence factor. The results indicate that the Self-confidence factor also has a loading on the measure of "Sureness" (the confidence level related to different opinions and predictions). This supports the claim that there are stable individual differences in confidence judgments which people assign to both answers to problems that have solution and answers whose correctness may never be known. It is worth noting that while "Sureness" ratings have high reliabilities and overlap with other metacognitive measures (MAI and Self-confidence), they have a *negative* correlation with measures of Fluid intelligence. Hence, people with higher Fluid abilities are less "Sure" in their opinions of some future events happening when veracity of these statements cannot be established.

General Discussion

Research on Self-confidence has been incomplete due to a lack of information about the relationship between confidence judgments and some related metacognitive measures. The studies reported in this paper show that the Self--confidence trait is an aspect of metacognition. That is, the results indicate that broad Self-confidence factor shares a meaningful relationship with measures of broad Self-concepts like those captured by the Memory and Reasoning Competence Inventory (MARCI), Metacognitive Awareness Inventory (MAI) and it extends beyond the immediate test-taking to events that may or may not happen. Our results also indicate that Self-confidence is factorially independent of cognitive abilities, personality traits, and mental speed measures

Metacognition is defined as "knowing about knowing" (Metcalfe & Shimamura, 1994, p. 1). The latter "knowing" refers to one's understanding of a task, one's own ability, knowledge, and other task-related factors, while the former "knowing" represents the assessment of one's own competency in having this understanding. There is no uniformly accepted listing of the different processes involved in metacognition, however, most theorists acknowledge its regulative aspect. Metacognitive Self-confidence is commonly regarded as an integral part of regulation or self-monitoring (Kleitman & Stankov, 2001; Pallier *et al*., 2002; Stankov & Crawford, 1996, 1997; Stankov, 1999, 2000) and it reflects one's belief in the accuracy of a decision made following a particular cognitive act. Self-confidence captures aspects of what Schraw and Dennison (1994) referred to as the Knowledge about Cognition facet of Metacognition – i.e., awareness about oneself as a cognizer and learner. Moshman (1994) called constructive metareasoning.

Our results may be seen within a broader context, including the debate about human rationality. As reported in Study 1, confidence judgments are mediated by the degree of uncertainty which people experience during test-taking (i.e., it is related to the response selection strategies). In particular, partial uncertainty was associated with both not being able to recollect the answer from memory, and having to infer the answer. This uncertainty originates from a state of limited knowledge, reflecting an interplay between known and unknown aspects of the questions. Thus, perhaps it is people's perception of how good they are in dealing with *partial* uncertainty, which, in turn, can be overcome by inference or reasoning processes that is of prime importance for understanding the nature of metacognitive Self-confidence. Baron (2000) points out that "if people *know* that their thinking is poor, they will not believe its results" (p. 64). As our findings indicate, there are individual differences in people's beliefs in the competency of their reasoning abilities. Perhaps the fact that people do lower their confidence ratings if they don't believe that their reasoning is good indicates that we are capable of being *rational*. This point is especially interesting because of our findings with the "Sureness" measure. People with lower level of Fluid abilities express somewhat higher level of "Sureness" in their opinions. This suggests that a more 'rational' assessment of one's performance is likely when it is based on actual outcomes, not some abstract situations.

In summary, the findings from the two studies presented in this paper suggest that Self-confidence is a metacognitive factor intrinsically linked to the processes that underlie metacognitive awareness during test-taking. The status of this factor needs to be considered within broader debates on human rationality.

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ПОВЕРЕЊЕ У СЕБЕ И МЕТАКОГНИТИВНИ ПРОЦЕСИ

Абстракт

У раду се испитује статус особине поверења у себе. Два истраживања чврсто заступају став да је поверење у себе компонента метакогниције. У првом истраживању које је обухватило 132 испитаника (N=132) примењена је евалуација појма о себи, недавно састављена листа способности памћења и мишљења (Memory and Reasoning Competence Inventory скр. MARCI) и тест вербалног мишљења (Verbal Reasoning Test скр. VRT). Резултати показују да постоји значајна корелација између процењивања поверења у себе VRT тестом и компоненте мишљења на MARCI листи. У другом истраживању у коме је учествовало 296 испитаника (N=296) примењена је велика батерија тестова знања и неколико критеријума метакогниције. Резултати истраживања показују да је присутно веома изражено поверење у себе и фактори метакогнитивне свести и да постоји значајна корелација међу њима. Поверење у себе не користи само процесе који су повезани са решавањем задатака који имају тачне одговоре, већ и уверења о догадјајима који се можда никада неће одиграти.
Кључне речи: процењивање поверења у себе, метакогниција, поверење у себе, метакогнитивно самопосматрање.

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ДОВЕРИЕ К СЕБЕ И МЕТАКОГНИТИВНЫЕ ПРОЦЕССЫ

Резюме

В предлагаемом труде исследуется статус качества доверия к себе. Два исследования отстаивают позицию, что доверие к себе является компонентом метакогниции. В первом исследовании, охватившем 132 испытуемых (N=132), применена оценка понятия о себе, недавно составленный перечень способностей памяти и мышления (Memory and Reasoning Competence Inventory сокр. MARCI) и тест вербального мышления (Verbal Reasoning Test сокр. VRT). Результаты исследования показывают, что существует значительная корреляция между оценкой доверия к себе VRT тестом и компонентом мышления на ведомости MARCI. Во втором исследовании, в котором приняли участие 296 испытуемых (N=296), применена большая группа тестов знаний и несколько критерий метакогниции. Результаты исследования показывают наличие очень выраженного доверия к себе и факторов метакогнитивного сознания, а также существование значительной корреляции между ними. Доверие к себе использует не только процессы, связанными с решением задач, которые имеют точные ответы, но также уверенностью в событиях, которые, может быть, никогда не сбудутся.
Ключевые слова: оценка доверия к себе, метакогниция, доверие к себе, метакогнитивное самонаблюдение.